

Boron (B) - Student Datasheet

Atomic number 5 - Metalloid - Group 13 - Period 2 - p-block

Boron is element 5, a metalloid whose electron-deficient bonding produces unusual clusters and network solids. The B₁₂ icosahedron, borates, borosilicate glass and two stable isotopes make it far more than a simple Period 2 tile.

Quick reference

Atomic number	5
Relative atomic mass	10.81
Electron configuration	[He] 2s ² 2p ¹
State at 20 C	Hard dark solid at 20 deg C
Density	2.34 g/cm ³
Melting point	2350 K
Boiling point	4273 K
Common oxidation state	+3
Electronegativity	2.04

Structure & orbitals

The viewer emphasizes a B₁₂ icosahedral building motif characteristic of important crystalline boron allotropes. It is a teaching motif, not a complete beta-rhombohedral unit cell.

The atomic 2p cloud is an isolated-atom probability model. Solid boron is a many-centre bonded network and cannot be interpreted as a collection of fixed atomic p-orbital "lobes."

Temperature / phase context

The simple temperature track uses evaluated bulk melting and boiling references, while the Structure panel separately explains allotropes and B₁₂ motifs. Exact transformation behavior among solid allotropes depends on conditions and is not reduced to an invented single marker.

Five things to remember

- Atomic number 5 means 5 protons.
- Neutral boron has three valence electrons: 2s²2p¹.
- Boron is classified as a metalloid.
- Important crystalline boron allotropes use B₁₂ icosahedral motifs.
- Natural boron is mainly ¹⁰B and ¹¹B, whose neutron interactions make isotope composition technologically important.

Boron: Real World & Signature Science

Boron is best understood through bonding: three valence electrons do not lead to a simple metal-like or ionic picture. Cluster and multicentre bonding help stabilize complex boron structures.

Why this element matters

Borosilicate glass Boron oxide in glass formulations helps produce useful thermal and chemical properties.	Boron carbide B ₄ C is an extremely hard boron-rich ceramic used for wear and neutron-absorption applications.
Neutron absorption 10B has a large neutron-capture cross section and is used in selected shielding, control and detector contexts.	Plant nutrition Boron is an essential micronutrient for plants, although the useful concentration window can be narrow.
Borate minerals Commercial boron is obtained from borate mineral deposits, not from native elemental boron.	

From borate minerals to useful boron materials: high-level context

1. Boron is concentrated in borate minerals formed in particular evaporitic and volcanic-geothermal settings.
2. Mining and beneficiation produce borate feeds; geology and annual production should be treated as dated datasets.
3. Chemical conversion yields boric acid, borates, boron oxide and other intermediates for glass, ceramics and specialty chemistry.
4. Elemental or high-purity boron production requires specialized industrial processes that are outside this educational overview.

Where on Earth?

Borate districts

Kir(k)a in Turkiye and Boron, California are selected borate-district examples; they do not represent all resources.

History

1808 - Joseph Louis Gay-Lussac and Louis Jacques Thenard, and independently Humphry Davy, produced impure boron.

19th-20th centuries - Better purification revealed boron's unusual hard, covalent solid forms.

Modern era - Borosilicate glass, boron carbide, borates and isotope applications expanded boron's industrial importance.

Today - Boron chemistry spans glass, ceramics, detergents, agriculture, semiconductors and neutron technology.

Uses

Glass & ceramics Borates and boron oxide are important in borosilicate glass, fiberglass and ceramic formulations.	Hard materials Boron carbide and related boron-rich ceramics provide high hardness and low density.
Agriculture Boron is an essential plant micronutrient supplied in controlled fertilizer forms.	Neutron technology 10B is useful for neutron absorption in selected detectors, shielding and control applications.

Boron: Isotopes, Questions & Evidence

Isotopes

¹¹B - Stable - major natural isotope

Reference teaching nucleus: 5 protons and 6 neutrons.

¹⁰B - Stable - minor but technologically important

Its strong neutron-capture behavior underlies several nuclear and detector applications.

Natural boron - Two stable-isotope mixture

The relative atomic mass reflects the natural mixture of ¹⁰B and ¹¹B.

Common questions

What is boron's atomic number?

5.

Is boron a metal?

No. Boron is usually classified as a metalloid.

How many valence electrons does boron have?

Three: 2s²2p¹.

What is boron used for?

Major uses include borosilicate glass and fiberglass, ceramics, agriculture and neutron-absorbing materials.

Why is boron's structure unusual?

Electron-deficient multicentre bonding supports cluster motifs such as B₁₂ icosahedra and complex network solids.

What is special about boron-10?

¹⁰B strongly absorbs neutrons, which makes it useful in selected detector and nuclear-technology contexts.

Quick self-check

1. **Atomic number?** Answer: 5

2. **Classification?** Answer: Metalloid

3. **Valence electrons?** Answer: 3

4. **Key structural motif?** Answer: B₁₂ icosahedron

5. **Which isotope is notable for neutron capture?** Answer: ¹⁰B

Evidence & provenance

Atomic and ordinary physical values are evaluated. The B₁₂ viewer is a reviewed structural motif, not a claim that all boron solids have one simple molecular structure. Commodity geography is kept distinct from bonding/allotrope science.

Core sources

Royal Society of Chemistry - Boron	https://periodic-table.rsc.org/element/5/boron
NIST - Atomic Data for Boron	https://physics.nist.gov/PhysRefData/Handbook/Tables/borontable1.htm
USGS - Mineral Commodity Summaries 2026	https://pubs.usgs.gov/publication/mcs2026